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Comparative Study on the Effects of Urea and Organic Fertilizers on Growth and Yield of Mung Bean (*Vigna radiata*)

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Abstract

Organic fertilizers are recognized for their role in enhancing soil health and promoting sustainable crop production. This study investigated the impact of different fertilizers—compost, vermicompost, cow dung, liquid biofertilizer, and DAP granules—on soil pH, plant growth, and yield of *Vigna radiata* (mung bean) during the summer season in Delhi. Each treatment involved a 1:1 ratio of soil to fertilizer, and the mixtures were analyzed beforehand for inorganic nutrients such as chloride, sulphate, and nitrate, as well as pH levels. Plant growth was assessed through several parameters, including germination percentage, shoot and root length, fresh and dry biomass, chlorophyll concentration in leaves, and the pH of leaf extracts. Yield was evaluated based on the number of flowers and pods produced per plant. Among all treatments, vermicompost resulted in the highest germination rate, longest shoot and root lengths, greatest biomass accumulation (both fresh and dry), and the maximum number of pods. Conversely, liquid biofertilizer showed the lowest germination, control plants had the shortest shoots, and cow dung treatment resulted in the shortest roots. Compost and biofertilizer treatments produced the lowest fresh and dry weights, respectively. In conclusion, the results indicate that vermicompost is highly effective in improving soil conditions, supporting vigorous plant growth, and significantly boosting the yield of mung bean crops.

Introduction

A wide variety of chemical fertilizers are utilized throughout the world in order to promote plant growth and enhance crop productivity. However, these chemical fertilizers are also widely known to cause tremendous harm to the soil and the environment and therefore to human health. Consumption of any plant part supplemented with chemical fertilizers can have a hazardous impact on humans and animals. Furthermore, chemical fertilizers pollute rivers, lakes and other reservoirs as they leach to the ground level, thereby impacting water bodies and eventually, animal and plant health. Organic fertilizers can be utilized as alternatives to chemical fertilizers because they are known to improve soil health and do not cause any harm to the environment. Ensuring long-term soil fertility and agricultural sustainability relies heavily on the use of organic fertilizers. Soil supplemented with large amounts of organic matter is known to retain more water and nutrients and promote the growth of soil microorganisms, thus improving soil health and quality (Bhavya et al. 2018). Therefore, organic amendments in agriculture can promote the physical, chemical and biological properties of the soil as well as the crop (Dinesh et al. 2012).

In this study, we report the impact of organic fertilizers on mung bean growth was evaluated using various growth parameters, including germination rate, shoot and root length, as well as fresh and dry biomass, number of pods; and some biochemical aspects viz. chlorophyll content, soil nutrient status and pH; were analyzed. The treatments comprise different fertilizers (compost, cow dung, liquid biofertilizer, vermicompost and DAP) in 1:1 parts of garden soil: fertilizer mixture. Mung bean can be easily grown in small pots, has fast growth and complete the reproductive cycle in a short time period therefore was selected in the present study (Irshad et al. 2006, Naeem et al. 2006, Mohan Naik et al. 2020). Mung bean popularly known as green gram, is native to India and widely cultivated in different continents. India contributes to the major market share of mung bean with the production of 1.9 million tonnes (Ministry of Agriculture and Farmers Welfare, India 2018). Mung beans are valued for their high protein content and are used in various forms—whole, split (dal), or sprouted—to promote nutritional balance in the human diet. It plays a vital role in soil fertility by enhancing the physical properties of soil and fixing atmospheric nitrogen (Mohan Naik et al 2020).

The current study aims to compare the effect of urea and different kinds of organic fertilizers on the growth and yield of mung beans. Plants treated with vermicompost had maximum germination rate, higher shoot & root length, dry weight, fresh weight, and the number of pods per plant as well. These organic fertilizers are less expensive, highly biodegradable and also non-pollutant to both aquatic and terrestrial ecosystems (Bandani et al. 2014, Ouda and Mahadeen 2008, Yossif and Ibrahim 2012). The application of organic fertilizer increases heterotrophic bacterial biomass, stimulates secondary productivity and mineralizes the nutrients for the stimulation of primary productivity (Bandani et al. 2014, Bharadwaj et al. 2021, Ji et al. 2017, Shaji et al. 2021, Sharma and Chetani 2007). As reported in this study as well, biofertilizers such as vermicompost and compost are highly rich in nutrients and can meet the demand for low nutrient content in the soil thereby increasing the growth and yield of plants.

Materials and methods

Organic matter, nitrates, chlorides, and sulphate content in untreated and treated soil samples

Six treatments were taken including five treatments of different soil fertilizer mixtures (1:1 parts soil and fertilizer mixture) namely compost, vermicompost, biofertilizer, cow dung, and DAP (Di-ammonium phosphate) were used respectively and only soil was taken as control. Soil mixtures were tested for the presence of inorganic nutrients, 10gm of soil mixtures from all treatments and control were taken and dissolved in 30 ml distilled water (1:3) separately. Stirred and kept for 15-20 minutes followed by filtration. The supernatant was taken for further testing. For nitrates, 10 ml of soil mixture solution from respective treatments was taken and 5 drops of diphenylamine were added and the presence of nitrates was observed when diphenylamine is oxidized, given blue colouration (Quinoidal complex). For sulphate, in 10 ml of soil mixture solution from respective treatments, 3 drops of $BaCl_2$ were added and showed white-coloured precipitate on $BaSO_4$ formation. For chlorides, in 10 ml of soil mixture solution from respective treatments, 4 drops of $AgNO_3$ were added and showed a white precipitate of $AgCl_2$. Further for Organic matter, a pinch of dry soil mixture from respective treatments was taken and 2 drops of H_2O_2 were added and produced effervescence of CO_2 suggesting the presence of organic matter. Furthermore, the pH of the soil mixture solution was initially tested with broad-range pH paper and then confirmed using narrow-range pH paper.

Response of Mung Bean Growth and Yield to Chemical and Different Organic Fertilizer Treatments

For each treatment, a total of 50 mung bean seeds were planted in trays to check the seed germination rate. The trays of all treatments and control were covered with cling film to maintain the humidity and kept under observation for 7 days.

Seed germination rate in different fertilizer treatments and control

The average germination rate after 7 days of seed sowing in compost, vermicompost, cow dung, biofertilizer liquid, DAP, and control was checked as:

Germination rate = Total number of germinated seeds/Total number of seeds sown X 100

Further, mean rate of seed germination (mean ± standard deviation) of seeds of mung maintained under constant temperature between 30 and 35°C was calculated.

Plant growth in different fertilizer treatments and control

To further evaluate the impact of each treatment on plant growth, the shoot and root lengths of 7-day-old seedlings (two sets of 10 seedlings per treatment) were measured using a scale. For the fresh weight of plants, 7 days old plantlets from the tray were plucked and washed to remove soil particles. From each treatment, 2 bunches of 10 seedlings from each treatment were taken and weighed on an electronic weighing scale. After that for dry weight, 2 bunches of 10 seedlings were wrapped in foil and kept in a hot air oven for drying for 4 hours, then 1 hour for cooling and weighed on an electronic weighing scale. Additionally, after 13 days of germination, 6 plants from each treatment were transferred to 3 pots with respective soil fertilizer mixture in 3:1 ratio and watered regularly. When plants reached their maturity (32 days), the leaves chlorophyll content and pH of leaf extract was measured. Chlorophyll content estimation from 300mg leaves of plants grown in different treatments was done. The leaf pieces kept in 7 ml of DMSO during incubation (dimethyl sulfoxide) at 50ºC for 2.5 hours. The supernatant was taken and leaf tissues were discarded after the incubation period is over and absorbance was checked at 645nm and 663nm wavelengths with the help of a spectrophotometer (Gallego et al. 1996, Kumawat et al. 2006). The total chlorophyll (Chl a and Chl b) content was measured using the formula-

Chlorophyll 'a' = 12.7 (A663) - 2.69 (A645) X V/ (1000 X W)

Chlorophyll 'b' = 22.9 (A645) - 4.68 (A663) X V / (1000 X W)

Total chlorophyll = 20.2 (A645) + 8.02 (A663) X V/ (1000 X W)

Where,

A = Absorbance at a specific wavelength (645nm, 653nm)

V = Final volume of the chlorophyll extract (ml)

W = Fresh weight of the sample (gm)

pH measurement

The reaction mixture was prepared by grinding the leaf sample with distilled water in a mortar and pestle. The prepared solution was filtered using filter paper into a beaker. The pH measurement was carried out using a digital pH meter.

For plant yield: The number of flowers per plant and the number of fruits per plant were calculated for each of the soil mixture treatments and control for 42 days old plants to observe the effect of different fertilizers on reproductive efficiency (Fakir et al. 2011).

Results and discussion:

In this section that follows, several morphological, biochemical, and physiological parameters examined are discussed as observed in order to evaluate how mung bean responds to the six distinct soil fertilizer treatments.

Organic matter, nitrates, chlorides, and sulphate content in untreated (control) and treated soil samples

Organic matter refers to the portion of soil composed of plant and animal residues at different stages of decomposition. It helps in maintaining soil ecology which in turn helps in plant growth and nutrition. A significant challenge to sustainable agriculture is the reduction of organic matter in the soil. In cow dung soil mixture, organic matter was highest (Table 1, Fig. 1). Soil organic matter enhances soil structure while simultaneously increasing the availability of nutrients. Availability of organic matter also contributes to crop growth and yield directly by supplying nutrients and indirectly by modifying soil physical properties such as stability of aggregates and porosity that can improve the root growth, and rhizosphere and stimulate plant growth (Goss, 2013). Nitrate plays an important role in nitrification and was higher in the case of compost (Table 3, Fig. 1A). Chloride is a vital micronutrient for plants and was maximum in vermicompost (Table 3, Fig. 1C). Another nutrient, sulphate when calculated, it was maximum in vermicompost (Table 3, Fig. 1B). Sulphates are responsible for nodulation, and chlorophyll formation and are also a co-factor in the activation of some enzymes. According to the study, the vermicompost-soil blend, containing higher levels of sulphates, nitrates, and organic material, significantly promoted mung bean growth, flowering, and fruiting. The growth rate of plants is significantly impacted by the availability of nitrogen, phosphorus, and potassium. As a component of chlorophyll, nitrogen plays a crucial role in promoting cell division and expansion within the apical meristem. The apical meristem's activity drives shoot elongation and contributes to plant height. The chemical balance of the soil is needed for the optimal growth of each plant as these ions participate in physiological processes involved in the growth and developmental mechanisms of the plants (Mangalassery et al., 2019).

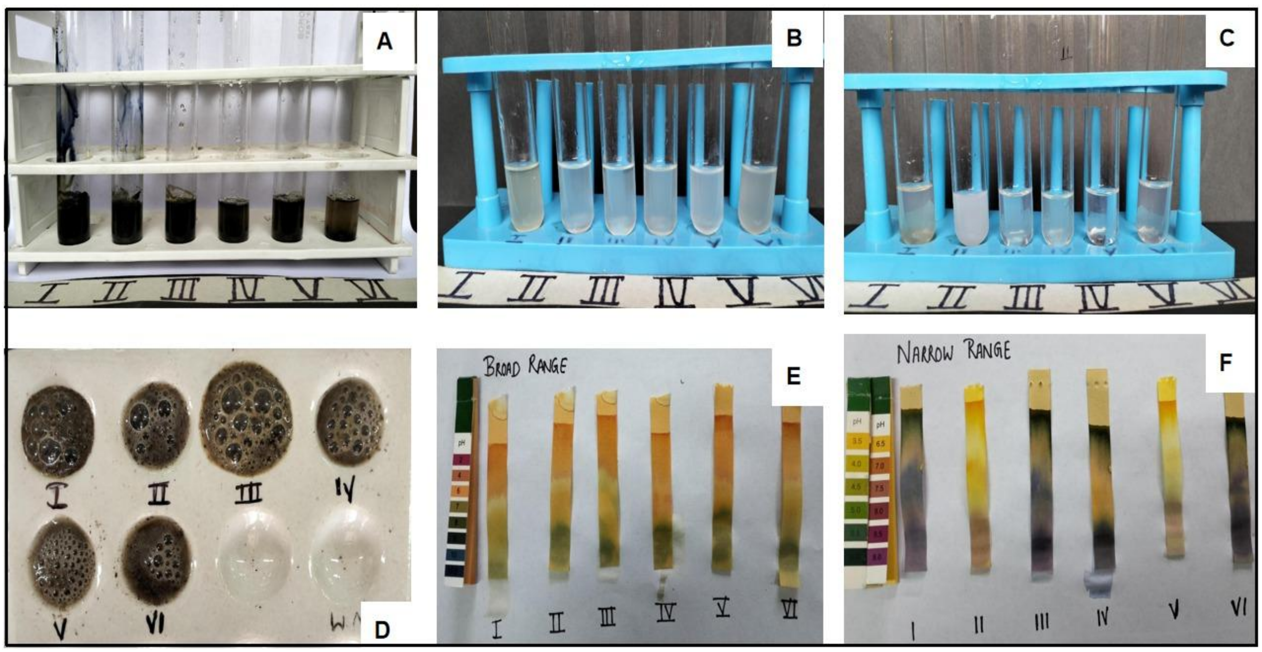


Fig. 1: Determination of the presence of inorganic nutrients in the soil blend. Test for (A) Nitrates (B) Sulphates (C) Chloride (D) Organic matter (E) pH (broad range) (F) pH (narrow range).

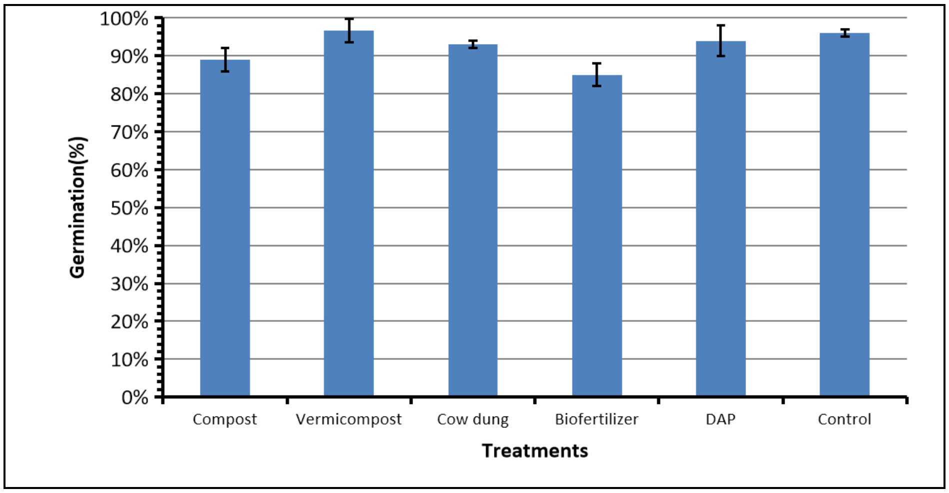
S. No.	Components	Compost (I)	Vermicompost (II)	Cowdung (III)	Biofertilizer (IV)	DAP (V)	Control (VI)
1	Nitrate	++++	+++	-	++	+++	+
2	Sulphate	+	+++	++	+	++	-
3	Chloride	+	++++	+	+	-	++
4	Organic matter	++	+	++++	++	+++	+
5	pH						
	Broad range	6-7	7-8	6-7	6-7	7-8	6-7
	Narrow range	6	6.5	6.5	5	5.5	6.5

Table 1: Nutrient content and pH were measured in untreated soil (control) and soil treated with different fertilizers.

Comparative Effects of Chemical and Organic Fertilizers on the Growth and Yield of Mung Bean (*Vigna radiata*)

Seed germination rate in different fertilizer treatments and control

Germination rate serves as an indicator of seed viability and vigor within a seed population. Seed germination is extremely vital for the regeneration and successful establishment of the next generation (Kheloufi et al. 2019). Therefore, providing a substratum to the seed that enhances the potential of the seeds to give rise to the seedlings is much needed where ensuring food security is the primary agricultural priority (Gharoobi et al. 2012, Xue et al. 2013). When the rate was calculated after 7 days of germination for each of the six treatments, it was highest in the seeds in control (untreated soil) indicating the initial requirements of the seeds to germinate are limited and minimal and supplementation with any additive is redundant at this stage. Other treatments namely, vermicompost, DAP, cow dung, compost and biofertilizer treatments show a slightly lower rate of germination, considering all the seeds used in this study were from a single lot, in order to eliminate the possibilities of genetic variations (Graph 1, Table 2, Fig. 2).



Graph 1: The germination rate of seeds sown in different treatments.

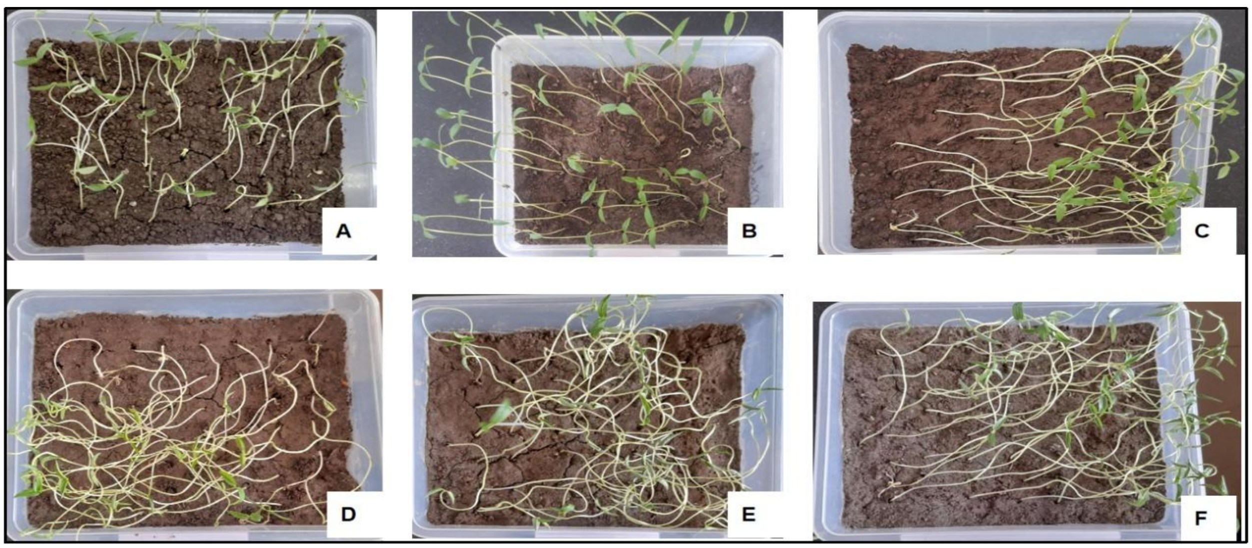


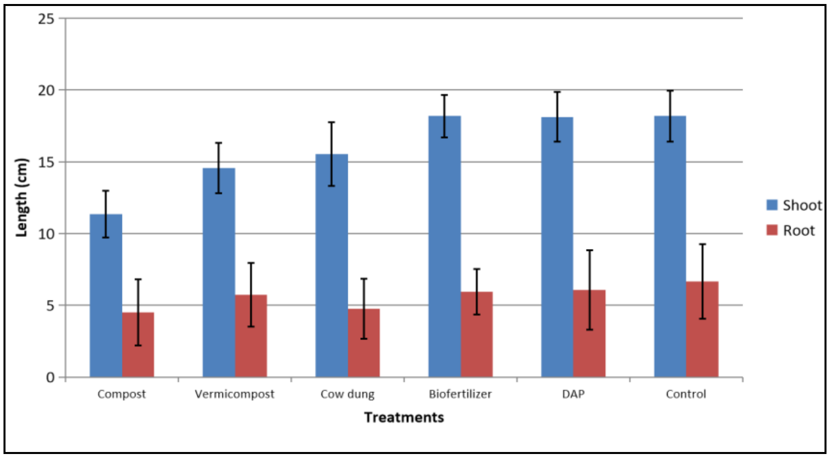
Fig. 2: Seed germination of mung bean after 7 days in different treatments. (A) Compost; (B) Vermicompost; (C) Cow dung; (D) Biofertilizer; (E) DAP; (F) Control (untreated).

Effect on plant growth in different fertilizer treatments and control

Root and shoot length

Root length is a critical factor, as longer roots allow plants to access deeper soil layers, improving nutrient absorption. The root length was calculated for 10 days old plantlets. It was found to be the highest with the vermicompost treatment (6.8±3.3 cm) (Graph 2, Table 2, Fig. 3) followed by DAP, control, biofertilizer, cow dung and the least in compost-treated soil. The shoot length of the treated seedlings were also calculated for

10 days old plantlets and was observed to be highest in DAP, and followed by vermicompost, control, biofertilizer, cow dung and compost. The increase in root and shoot length in plants treated with vermicompost and DAP is likely a result of elevated organic matter and nutrient supply. Enhancing soil with fertilizers raises organic matter levels, resulting in decreased bulk density and improved soil looseness. Thus, plants get a suitable growing environment which promotes better growth and development (Tarafder et al, 2020).



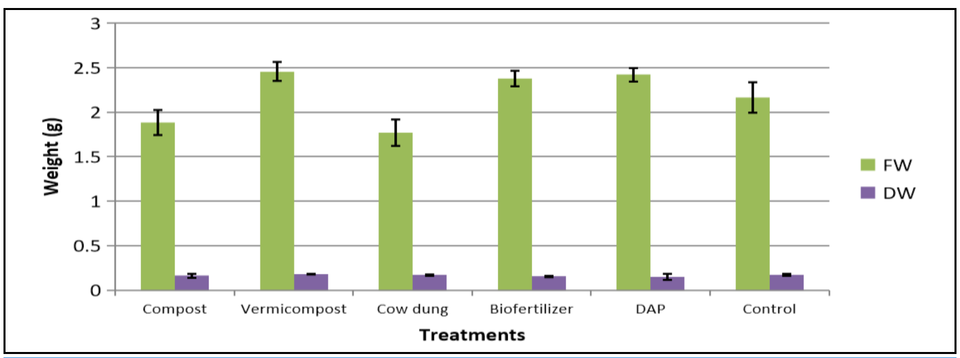
Graph 2: Shoot and root length of mung bean plants (10 days old seedlings) grown in soil mixture of different fertilizers.

Fig. 3: Comparison of plant seedlings (root and shoot length) after 10 days of germination (A) compost; (B) vermicompost; (C) cow dung; (D) biofertilizer; (E) DAP; (F) control.

Fresh weight and dry weight

Fresh weight is the data recorded of plant weight which includes the water content present in the plant. Dry weight, on the other hand, is the weight recorded after drying the plants at a higher temperature eliminating the entire water content from the plants (Garciano et al. 2006).

Both the fresh weight and dry weight of 10-day-old seedlings were recorded and the maximum observed in vermicompost treated plants indicated the maximum accumulation of organic matter in these plants (Graph 3, Table 2). Worms facilitate the solubilization of organic acids and the chelation of oxoacids originating from sugars, and exchange reactions in the surrounding environment lead to increased biomass in mung bean plants. The increase in the total dry matter production may be due to better source and sink capacity developed due to better dry matter production in and its accumulation in assimilatory surface area and increase in the photosynthetic efficiency and thus increased the production of photosynthates reflected in better growth and ultimately in higher dry accumulation (Verma et al 2022).



Graph 3. Graph presenting fresh weight (FW) and dry weight (DW) measurements of 10-day-old seedlings grown under different fertilizer treatments.

Chlorophyll content and pH of leaf extract in different fertilizer treatments and control

Plantlets after 13 days of sowing were transplanted in 8-inch pots in respective soil mixture treatments for further analyses of growth (Fig. 4, 5). When plants are exposed to sub-optimal conditions, they undergo physiological and biochemical fluctuations. Different biochemical analyses like chlorophyll content of fully expanded leaves of 32 days old plants, and pH of leaf extract were estimated in order to evaluate the physiological responses exhibited by plants growing in different soil mixture treatments.

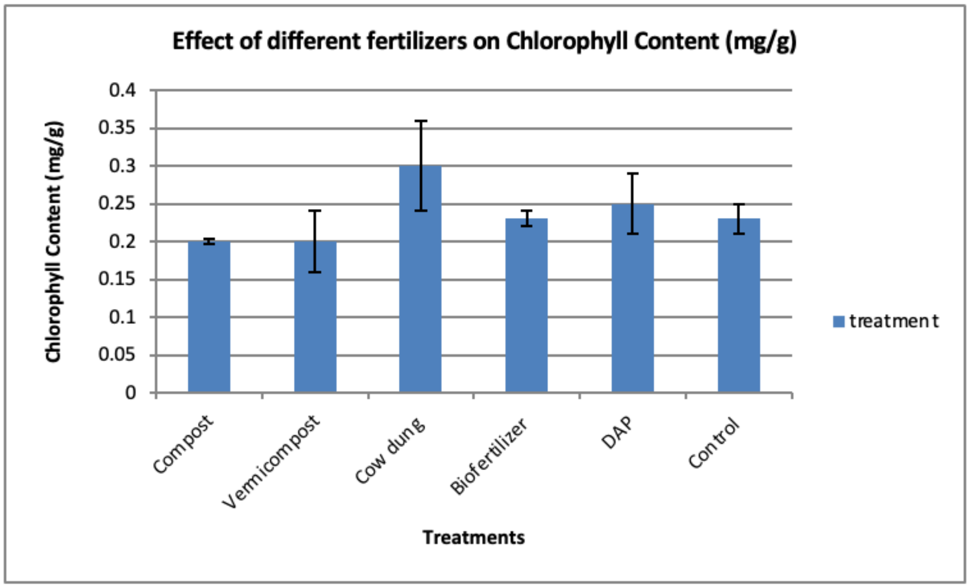
Fig. 4: The picture shows the plant growth in different fertilizers after transferring it into the pots

Fig. 5: Morphological variations in the plant length of mung bean plants after 2, 3 and 4 weeks of germination in different treatments.

Treatment	Germination rate (%)	Root Length (cm)	Shoot Length (cm)	Fresh weight (g)	Dry weight (g)	pH of leaf extract	Total chlorophyll content from leaves (mg/g)
Compost	89±0.03	4.64±2.9	11.375±2.4	1.884±0.13	0.162±0.022	7.05±0.15	0.20±0.004
Vermicompost	96±0.04	6.8±3.3	18.5875±2.5	2.456±0.10	0.18±0.006	6.94±0.11	0.20±0.04
Cow dung	93±0.01	4.785±2.4	15.6575±3.03	1.768±0.14	0.17±0.008	7.06±0.34	0.30±0.06
Biofertilizer	85±0.03	5.955±2.1	18.19±2.01	2.376±0.08	0.154±0.004	7.1±0.16	0.23±0.01
DAP	94±0.04	6.2575±3.7	18.5975±2.5	2.422±0.07	0.15±0.031	6.97±0.17	0.25±0.04
Control	96±0.01	6.005±3.3	18.215±2.1	2.166±0.17	0.172±0.011	6.82±0.02	0.23±0.02

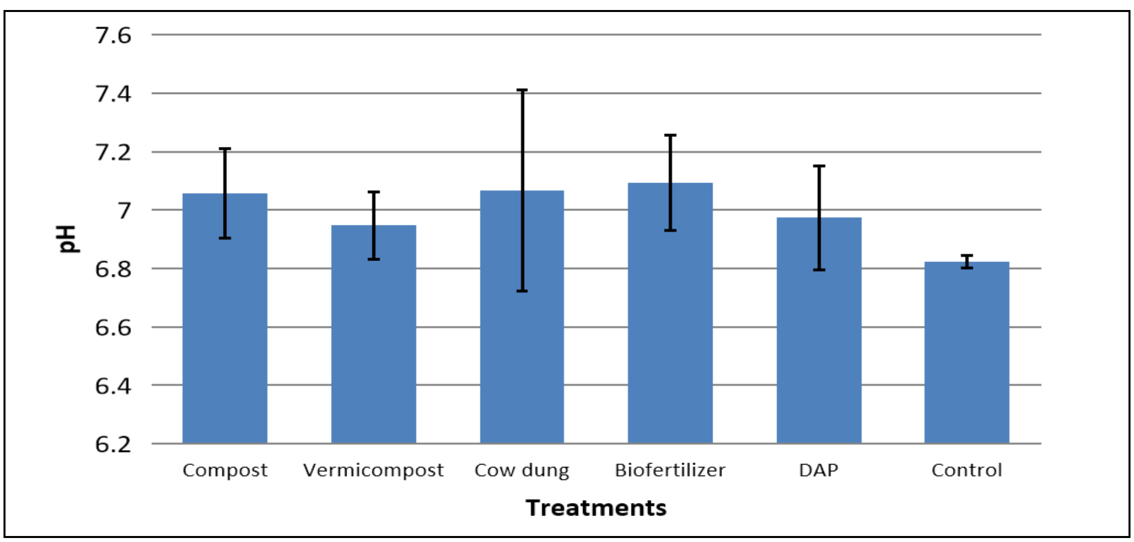
Table 2. Table displaying germination rate, shoot length, root length, and fresh and dry biomass of mung bean plants and pH of leaf extract and total chlorophyll in leaves treated with different fertilizers.

Chlorophyll is an important photosynthetic pigment which largely determines the photosynthesis rates and plant growth. The higher the chlorophyll content, the higher will be the photosynthesis rate. The chlorophyll concentration indicates the health of plants which therefore will be resulting in higher production of fruits. To estimate the chlorophyll content of the treatment, the chlorophyll was extracted from leaves of 32 days old plantlets, and a standard deviation was applied to the collected data. The present study has inferred that the plants grown in soil - cow dung mixture showed the highest chlorophyll content (Graph 4, Table 2). A sufficient level of chlorophyll is necessary to preserve photosynthetic pigments and synthesize enzymes that contribute to increased growth and productivity in mung plants.



Graph 4. Effect of different fertilizers on chlorophyll content (mg/g).

pH is an indication of acidity or alkalinity. In this study, the pH of the plant leaf extract was determined. As the hydrogen ions increase in leaves the pH decreases or vice-versa. It was observed that the pH of leaves of the treatment ranges from 6.89-7.28 in between the neutral pH range (Graph 5) with no potential detrimental impact on nutrient availability for crops. The data was collected and a standard deviation was applied to validate the data.



Graph 5. Graph showing pH measured in the plants (32 days plants)**.**

The plants were also evaluated for their reproductive potential (Rehman et al. 2009) wherein the number of flowers per plant and count of fruits per plant was calculated for each of the soil mixture treatments for 42 days old plants. The data showed that the number of flowers and fruits was maximum in the vermicompost-grown plants while it was lowest in control plants as indicated by mean production of flowers and fruits per plant (mean ± standard deviation) of mung (Table 3).

Treatments	No. of flowers per plant	No. of Fruits per plant
Compost	4±1.15	3±1.5
Vermicompost	6±3	5±2.5
Cow dung	5±2.5	4±1.7
Biofertilizer	4±1.5	3±0.5
DAP	3±1.15	3±1.5
Control	2±1	2±1.5

Table 2. Table showing count of flowers and number of fruits in mung bean plants grown in soil mixture treated with different fertilizers.

Conclusion

The research focused on analyzing the effects of chemical and organic fertilizers on mung bean (Vigna radiata) by measuring growth-related parameters such as germination rate, shoot and root development, biomass (fresh and dry), and reproductive performance. Physiological and biochemical studies were also performed. The findings revealed that mung bean plants grown in a soil and vermicompost mixture exhibited the highest seed germination rate, as well as the greatest shoot and root lengths, along with maximum fresh and dry biomass. Plants grown in vermicompost soil mixture when biochemically tested showed a higher composition of nitrate, and sulphate with a pH of 7.5 thus providing a suitable environment for the plant. The vermicompost also promoted flower production which further increased the reproduction efficiency of the mung bean plants resulting in higher fruit production. The studies validated that vermicompost not only enriches soil with essential nutrients and increases yield but also offers a sustainable substitute for synthetic chemical fertilizers. Effective use and management of organic fertilizers can minimize the need for chemical inputs, offering cost-saving benefits to smallholder farmers.

References:

Bandani M, Mobasser HR, Sirusmehr A (2014) Effect of Organic Fertilizer on Quantitative yield of mung bean (*Vigna radiata* L). Journal of Novel Applied Sciences. 6(4.28ns), 367-370.

Bhavya G, Shaker, KC, Jayasree G, Reddy MM (2018) Effect of Phosphorus, Biofertilizers and Organic Manures on Root Nodulation and Productivity of Green Gram (Vigna radiata L.). International Journal of Current Microbiology and Applied Sciences. 7(6), 1140-1145.

Bharadwaj B, Sahu K, Kumari N, Sharma S, Tamanna, Mishra R, Geeta, Soni R (2021) Morphological, physiological and biochemical facets of Ricinus communis and Ficus racemosa plants grown at three different sites. Hans Shodh Sudha. 1(4), 50-63.

Dinesh R, Srinivasan V, Ganeshamuthry AN, Hamza, SS (2012) Effect of organic fertilizers on biological parameters influencing soil quality and productivity. Organic Fertilizers: Types, Production and Environmental Impact. Rajeev Pratap Singh (Ed.). Agriculture Issues and Policies. Nova Science Publisher Inc. New York, 23-46.

Fakir MSA, Mondal MMA, Ismal MR, Ashrafuzzaman M (2011) Flowering pattern and reproductive efficiency in mungbean. International Journal of Agriculture and Biology. 13(6), 966-970.

Gallego SM, Benavides MP, Tomaro ML (1996) Effect of heavy metal ion excess on sunflower leaves: evidence for involvement of oxidative stress. Plant Science. 121(2), 151-159.

Gharoobi B, Ghorbani M, Nezhad MG (2012) Effects of different levels of osmotic potential on germination percentage and germination rate of barely, corn and canola. Iranian Journal of Plant Physiology. 2, 413-417.

Goss MJ, Tubeileh A, Goorahoo D (2013). A review of the use of organic amendments and the risk to human health. Advances in agronomy. 120, 275-379.

Graciano C, Goya J.F, Frangi J.L, Guiamet J.J (2006) Fertilization with phosphorous increases soil nitrogen absorption in young plants of Eucalyptus grandis. Forest Ecology and Management, 202-210.

Irshad L, Dawar S, Zaki MJ (2006) Effect of different dosages of nursery fertilizers in the control of root rot of okra and mung bean. Pakistan Journal of Botany. 38(1), 217-223.

Ji R, Dong G, Shi W, Min J (2017) Effects of Liquid Organic Fertilizers on Plant Growth and Rhizosphere Soil Characteristics of *Chrysanthemum*. Sustainability. 9(5), 1-16.

Kheloufi A, Boukhatem FZ, Mansouri LM, Djelilate M (2019) Maximizing seed germination in five species of the genus *Acacia* (Fabaceae,Mimosaceae). Reforesta. 7, 15-23.

Kumawat RN, Rathore PS, Nathawat NS, Mahatma M (2006) Effect of Sulfur and Iron on Enzymatic Activity and Chlorophyll Content of Mungbean. Journal of Plant Nutrition. 29(8), 1451-1467.

Mangalassery S, Kalaivanan D, Philip PS (2019) Effect of inorganic fertilizers and organic amendments on soil aggregation and biochemical characteristics in a weathered tropical soil. Soil and Tillage Research.187, 144-151.

Mohan Naik G, Abhirami P, Venkatachalapathy N. (2020) Mung Bean. In Pulses Springer, Cham, pp. 213-228.

Naeem M, Iqbal J, Bakhsh MAAHA (2006) Comparative Study of Inorganic Fertilizers and Organic Manures on Yield and Yield Components of Mungbean (*Vigna raddiata* L.). Journal of Agriculture and Social Science. 2(4), 227-229.

Ouda B.A, Mahadeen A.Y (2008) Effect of Fertilizers on Growth, Yield, Yield Components, Quality and Certain Nutrient Contents in Broccoli (*Brassica oleracea*). International Journal of Agriculture and Biology. 10(6), 627-632.

Rehman A, Khalil SK, Nigar S, Rehman S, Haq I, Akhtar S, Khan AZ, Shah SR (2009) Phenology, plant height and yield of mungbean varieties in response to planting date. Sarhad Journal of Agriculture. 25(2), 147-151.

Shaji H, Chandran V, Mathew L (2021) Organic fertilizers as a route to controlled release of nutrients. In Controlled Release Fertilizers for Sustainable Agriculture Academic Press,
pp. 231-245.

Sharma A, Chetani R (2007) A Review on the Effect of Organic and Chemical Fertilizers on Plants. International Journal for Research in Applied Science and Engineering Technology. 5(2), 677-680.

Tarafder S, Rahman MA, Hossain MA, Chowdhury MAH (2020) Yield of *Vigna radiata L.* and post-harvest soil fertility in response to integrated nutrient management. Agricultural and Biological Sciences Journal. 6(1), 32-43.

Verma R, Singh M, Dawson J, Muddassir P, Khan I (2022) Effect of bio-fertilizers and organic manures on growth and yield of green gram (*Vigna radiata L.*). The Pharma Innovation Journal. 11(4), 1599-1602.

Xue A, Ming-hui Z, Qian Z, Jie L, Hui-jun Z, Hai-ying W, Cui-mei Y, Chunhong L, Xing-dong Y, Fu-ti X, Xiao-r H (2013) Study on Plant Morphological Traits and Production Characteristics of Super High-Yielding Soyabean. Journal of Integrative Agriculture. 12(7), 1173-1182.

Yossif AM, Ibrahim YM (2012) Effect of Fertilizers (Urea, Farmyard, and Chicken Manure) on Growth and Yield of Rhodes Grass (*Chloris gayana* L. Knuth). Global Journal of Plant Ecophysiology. 2(1), 18-22.